Eclipse Arrowhead
Cyber architecture for complex System of Systems

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To see the Eclipse Arrowhed video click here or go to https://youtu.be/vf28cQVgPss
OT meets IT

2015+
The 4th industrial platform

IndTech

Technology

Engineering Tools

Market

OT

IT

Production

SmartCity

Energy

Building

5G

IoT

SoS

Big Data Analytics

Block Chain

AI

UX

1980+
Proprietor Automation & Industrial OT

Life Science

Bank & Finance

www.arrowhead.eu
Architecture basics

- Micro-service Architecture - SOA
  - Look-up
  - Late binding
  - Loosely coupled
- Interoperability
  - Multi-protocol, multi-technology
  - “one size never fits all”
- Integration platform
  - To integrate OT and IT, with IoT
- Model Based Engineering - MBE
  - SysML
Key architecture concepts

- Service registry -
  - Look-up - what's available

- Orchestration
  - Late binding and loosely coupled
  - Dynamic and run-time changes

- Security
  - Authentication, Authorisation and Audit
  - Payload encryption
  - Security to the edge
Key architecture concepts

• Local clouds
• Self contained secure
• From cloud to edge
• System of local clouds
• microservice integration between local clouds
Key architecture concepts

- Local clouds
- Self contained secure
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- System of local clouds
- microservice integration between local clouds
Interoperability - Protocol translation

Translation between different protocols
HTTP, CoAP, MQTT, Websocket

Service A

System P

Translator

Service A Contract

A_SD → A_IDD
A_CP
A_SP

Service A*

System C

A_SD → A*_IDD
A*_CP
A_SP

Service A* Contract
Interoperability
Multi-protocol, multi-technology

Support core systems models
Translator
HTTP (REST), CoAP, MQTT, (Websocket)
Adaptors to other communication protocols
OPC-UA <-> Arrowhead
Modbus TCP <-> Arrowhead
Z-wave <-> Arrowhead
ZigBee <-> Arrowhead
IO-link <-> Arrowhead
Thing of Web <-> Arrowhead
Datamodel adaptor
ISO 10303 - STEP AP-242
Automation engineering
Engineering process integrated by SOA

Modelling the engineering process - IEC 81346 + extensions
Model based engineering providing a flexible integration of solution architecture and the engineering process!!
Eclipse Arrowhead v4.4.1
Eclipse Arrowhead v4.4.1

**Engineering tools**
- SysML 1.6 profile
- Eclipse Kura
- Eclipse Kapua
- Eclipse hawkBit
- Eclipse Arrowhead

**Management support:**
- Management Tool
- Translation
- Gatekeeper
- Gateway
- Configuration
- Plant Description
- Management Tool
- Test Tool
- Sandbox Tool
- Solution MBE

**Supply chain/product life cycle**
- Contract Proxy

**Execution support**
- Choreography
- Workflow Manager
- Workflow Executor

**Control support**
- Control Strategy

**System of Systems support**
- Event Handler
- Data Manager
- Eclipse hawkBit
- Eclipse Kura
- Eclipse Kapua

**Inter cloud service exchange**
- Gatekeeper
- Gateway

**Interoperability**
- Translation
- FiWare
- 61499
- Modbus TCP
- OPC-UA
- Z-wave

**Security infrastructure**
- System Registry
- Device Registry
- On-boarding
- Security Compliance
- Security Mitigation

**Local cloud basic properties**
- Service Registry
- Authorisation
- Orchestration
- Certificate Authority

**Release candidates v4.5.0**
- Released
- Separately released

**Tool chain interoperability**
Eclipse Arrowhead v5.0.0

Currently being specified

Primary objective

Lower the entry step

Robustness

Some changes to mandatory core system

Documentation stringency

Extended interoperability -

Data models, ISO 10303, ISO 15926, IEC81346, BIM, ...
V&V in industrial production

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10+ use cases with considerable engineering cost savings

Objective 20-50% cost reduction

Actual 30-95% cost reduction compared to current industrial state of the art
Comparison to other technologies
## IoT-SoS Architectures & Platforms

<table>
<thead>
<tr>
<th>Features</th>
<th>Arrowhead</th>
<th>AUTOSAR</th>
<th>BaSyx</th>
<th>FIWARE</th>
<th>IoTvity</th>
<th>LWM2M</th>
<th>OCF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key principles</strong></td>
<td>SOA, Local Automation Clouds</td>
<td>Runtime, Electronic Control Unit (ECU)</td>
<td>Variability of production processes</td>
<td>Context awareness</td>
<td>Device-to-device communication</td>
<td>M2M, Constrained networks</td>
<td>Resource Oriented REST, Certification</td>
</tr>
<tr>
<td><strong>Real-time</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes (IoTvityConstrained)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Run-time</strong></td>
<td>Dynamic orchestration and authorization, monitoring, and dynamic automation</td>
<td>Runtime Environment layer (RTE)</td>
<td>Runtime environment</td>
<td>Monitoring, dynamic service selection and verification</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Distributed</strong></td>
<td>Distributed</td>
<td>Centralize</td>
<td>Centralize</td>
<td>Centralize</td>
<td>Centralize</td>
<td>Centralize</td>
<td>Centralize</td>
</tr>
<tr>
<td><strong>Open Source</strong></td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td><strong>Resource accessibility</strong></td>
<td>High</td>
<td>Low</td>
<td>Very low</td>
<td>High</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Supporters</strong></td>
<td>Arrowhead</td>
<td>AUTOSAR</td>
<td>Bsys 4.0</td>
<td>FIWARE Foundation</td>
<td>Open Connectivity Foundation</td>
<td>OMA SpecWorks</td>
<td>Open Connectivity Foundation</td>
</tr>
<tr>
<td><strong>Message patterns</strong></td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl, Pub/sub</td>
<td>Req/Repl</td>
</tr>
<tr>
<td><strong>Transport protocols</strong></td>
<td>TCP, UDP, DTLS/TLS</td>
<td>TCP, UDP, TLS</td>
<td>TCP</td>
<td>TCP, UDP, DTLS/TLS</td>
<td>TCP, UDP, DTLS/TLS</td>
<td>TCP, UDP, DTLS/TLS</td>
<td>TCP, UDP, DTLS/TLS, BLE</td>
</tr>
<tr>
<td><strong>Communication protocols</strong></td>
<td>HTTP, CoAP, MQTT, OPC-UA</td>
<td>HTTP</td>
<td>HTTP, OPC-UA</td>
<td>HTTP, RTPS</td>
<td>HTTP, CoAP</td>
<td>CoAP</td>
<td>HTTP, CoAP</td>
</tr>
<tr>
<td><strong>3rd party and Legacy systems adaptability</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td><strong>Security Manager</strong></td>
<td>Authentication, Authorization and Accounting Core System</td>
<td>Crypto Service Manager, Secure Onboard Communication</td>
<td>–</td>
<td>Identity Manager Enabler</td>
<td>Secure Resource Manager</td>
<td>OSCORE</td>
<td>Secure Resource Manager</td>
</tr>
<tr>
<td><strong>Standardization</strong></td>
<td>Use of existing standards</td>
<td>AUTOSAR standards</td>
<td>Use of existing standards</td>
<td>FIWARE NGSI</td>
<td>OCF standards</td>
<td>Use of existing standards</td>
<td>OCF standards</td>
</tr>
</tbody>
</table>


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Resources

Youtube
https://www.youtube.com/channel/UCC-kTqFXh7StNwR7IFCRCjw

Web
www.arrowhead.eu/eclipse-arrowhead
www.arrowhead.eu/arrowheadtools

Github - code and documentation
www.github.com/eclipse-arrowhead

Book
www.arrowhead.eu
Conclusions

- Eclipse Arrowhead can implement architectures like
  - ISA95
  - RAMI4.0
- Engineering efficiency is very high compared to current state of the art
- Open source as Eclipse Arrowhead v4.4.1
- Already in commercial use by several companies